2.4 Signature Fluctuations Conceptual Model Specification

The echo signal from a complex target in motion is rarely, if ever, constant. The variation in the echo signal may be caused by meteorological conditions, the lobe structure of the antenna pattern, equipment instabilities, or variations in the target cross section. The cross sections of complex targets (the typical target of interest to radars) are sensitive to aspect. Therefore, as the target aspect changes even slightly relative to the radar, variations in the echo signal will result. Fluctuations of the received target signal impact the predictions of both target detection and target tracking performance.

Although radar detection thresholds typically are calculated as the signal to noise ratio required to detect a single pulse, actual target detection occurs as the group of pulses in the observation period is integrated in some manner. Variation in the received target signal during the observation period causes a degradation in this integrated signal, resulting in an increase in the threshold required for target detection. Similarly, the improvement of the received signal-to-noise ratio due to signal integration is degraded by signature fluctuations during the integration time. The large amplitude fluctuation of RCS with respect to small changes in the viewing angle is referred to as scintillation.

Signature fluctuations also impact target angle and range tracking. A complex target can be envisioned as a set of scatterers with an apparent centroid that is a function of the relative locations and efficiency of each scatterer. Signature fluctuation causes movement of this apparent centroid, resulting in movement of the target tracking point. This phenomenon is known as glint or bright spot wander.

For target detection, proper accounting for target cross-section fluctuations involves use of the probability density function and the correlation properties with respect to time for a particular target and type of trajectory. The procedure to experimentally determine the correct density function and autocorrelation function requires an immense amount of data for each target and radar type. Usually, this is not practical. An economical method to assess the effects of a fluctuating cross section is to postulate a reasonable model for the fluctuations and to analyze it mathematically. Several types of probability distributions have been proposed as reasonable models for signature fluctuations. Among these are the chi-square family, the log-normal family, the Swerling models, the Weinstock models, and the non-fluctuating model. Most of these models have been shown to match (approximately) some empirical data sets, but no general theory of target modulation exists.

The non-fluctuating case models a perfectly steady target echo. This is not realistic for real radar targets except in special cases such as spheres or targets which are stationary over the observation time. However, this model could be used to give detection estimates when minimal target information is available.

Swerling case 1 models a complex target consisting of many independent scatterers of approximately equal echoing areas. This model assumes that the echo pulses received from a target on any one scan are of constant amplitude throughout the entire scan but are independent (uncorrelated) from scan to scan. This assumption ignores the effect of the antenna beam shape on the echo amplitude. An echo fluctuation of this type is referred to as scan-to-scan fluctuation. Swerling case 2 models the same type of target as case 1. However, case 2 assumes that the fluctuations are more rapid than in case 1 and are independent from pulse to pulse.

Swerling case 3 models a target that can be represented as one large reflector combined with other smaller reflectors. The fluctuations are assumed to be independent from scan to scan as in case 1. Swerling case 4 models the same type of target as case 3, but with more rapid fluctuations that are independent from pulse to pulse (as in case 2).

The Swerling fluctuation models are special cases of chi-square distributions. Cases 1 and 2 are of degree 2 and are referred to as the Rayleigh-power or exponential distributions. Cases 3 and 4 are chi-square of degree 4.

General chi-square distributions also can be used to model signature fluctuations. Analysis of test measurements of an aircraft flying straight and level courses shows that fluctuations usually can be well-fitted by chi-square distributions with degrees ranging from 1.8 to 4. Although the chi-square distribution with degrees other than 2 or 4 have fit empirical data, the models generally are not based on a physical scattering mechanism.

One case where a physical connection to a different chi-square model has been demonstrated is the Weinstock distribution. This is a chi-square distribution of degree less than 2. Weinstock showed that this distribution can describe certain simple shapes, such as cylinders or cylinders with fins.

Log-normal distributions have been used to model scattering from highly directive reflectors when viewed from random aspects. Examples include randomly oriented flat plates, corner reflectors, and antennas. Ship cross sections also have been modeled in this way. Most of this modeling has been based on empirical rather than theoretical considerations.

Few, if any, real targets precisely fit any of these distributions. Even if the exact statistical distribution of a target were known, the actual radar measurement of a target on a particular flight path might not have a clear relationship to that distribution. The Signature Fluctuations

Functional Element is intended to generate statistical changes in target signal returns that are generally accepted as realistic, and to simulate the effects of these changes on radar detection.

2.4.1 Functional Element Design Requirements

This section contains the design requirements necessary to fully implement the signature fluctuations simulation.

1. ALARM will provide a capability for user selection of fluctuating target distributions from among the following seven statistical distributions:

   No Fluctuation
   Swerling Type 1
   Swerling Type 2
   Swerling Type 3
   Swerling Type 4
   General Chi-Square
   Weinstock
   Log-Normal

   A non-fluctuating target simply uses the constant radar cross section at the appropriate aspect angle without modification for fluctuations. The Swerling and Weinstock distributions are specific types of chi-square distributions. The remaining possibilities are standard probability distributions.

2. ALARM will provide a capability for the user to select a single distribution or combinations of aspect-dependent distributions to describe the fluctuations of a single target.

   A user will be able to select any of the seven distributions listed above for each aspect segment. For general chi-square, Weinstock, and log-normal distributions, values of distribution parameters may be specified for each segment.

2.4.2 Functional Element Design Approach

This section describes the design elements that implement the design requirements of the previous section. A design element is an algorithm that represents a specific component of the FE design.

ALARM implements the effects of target fluctuations by including a fluctuation loss in the calculation of integration gain. Fluctuation loss (L_f) is defined to be "the ratio between detectability factors of the fluctuating target and of a non-fluctuating target" [A.1-25, page 72]; i.e.,

$$L_f = \frac{D_o(f)}{D_o(n)} \qquad (2.4\text{-}1)$$

where $D_o(f)$ = detectability factor for fluctuating target (absolute)
$D_o(n)$ = detectability factor for non-fluctuating target (absolute)

Since integration gain is also described in terms of D_o, it is efficient to combine these calculations. See Section 2.25 for a description of the ALARM implementation of integration gain. Instead of using equation (2.4-1) directly, the ALARM implementation of the first requirement (design elements 4.1 - 4.3) is based primarily on an earlier subroutine called THRESH, developed in 1985 by Jon Dovala for Swerling, Manasse, and Smith [A.1-26]. All of the following formulas for fluctuation loss, except for non-fluctuating targets, are valid only for $0.1 \leq P_d \leq 0.9$ and $10^{-12} \leq P_{fa} \leq 10^{-4}$ [A.1-25, page 65].

Design Element 4-1: Intermediate Values

Intermediate variables g_{fa} and g_d are used in calculation of both fluctuation loss and integration gain. The equations defining g_d and g_{fa}, based on [A.1-25, page 65], are given below.

$$g_{fa} = 2.36\sqrt{(-\log P_{fa})} - 1.02 \qquad (2.4\text{-}2)$$

and

$$g_d = \frac{1.231t}{\sqrt{1-t^2}} \qquad (2.4\text{-}3)$$

where P_{fa} = probability of false alarm
t = $0.9\,(2P_d - 1)$
P_d = probability of detection

The user inputs P_{fa} and P_d are independent of aspect angle.

Design Element 4-2: Fluctuation Loss for Non-Fluctuating Target

For a non-fluctuating target, there is no loss due to fluctuation, so the fluctuation loss factor (L_f) is equal to unity; i.e.,

$$L_f = 1 \tag{2.4-4}$$

Design Element 4-3: Fluctuation Loss for Chi-Square Targets

Based on equation 2.45 of [A.1-25], ALARM calculates fluctuation loss for a general chi-square target as follows:

$$L_f = [(-\ln P_d)(1 + g_d/g_{fa})]^{-1/kF} \tag{2.4-5}$$

where P_d = probability of detection
k = number of degrees of freedom (chi-square parameter)
F = number of correlated blocks

Note that the user must specify k and F for each aspect sector which uses a chi-square distribution, but P_d is not aspect-dependent.

The Swerling distributions are special cases of chi-square distributions; the values of kF used in those cases are defined as follows [A.1-25, pages 76-77]:

$$kF = \begin{cases} 1 & \text{for Swerling 1} \\ N_p & \text{for Swerling 2} \\ 2 & \text{for Swerling 3} \\ 2N_p & \text{for Swerling 4} \end{cases} \tag{2.4-6}$$

where N_p = number of pulses integrated

A Weinstock distribution is also a special case of a chi-square distribution with F=1 and $0.3 \leq k \leq 0.7$ [A.1-25, page 77]. Thus, for a Weinstock distribution

$$kF = k \qquad (2.4\text{-}7)$$

where k = number of degrees of freedom (user input)

Design Element 4-4: Fluctuation Loss for Log-Normal Targets

The fluctuation loss for a log-normal target is defined in equation 2.56 of [A.1-25] as follows:

$$L_f = \left[\frac{\exp\left(\frac{\sigma^2}{2} + \sigma g_d\right)}{\left(1 + g_d / g_{fa}\right)} \right]^{\frac{1}{N_i}} \qquad (2.4\text{-}8)$$

where σ = standard deviation of ln (S/N) (see equation (2.4-10))
N_i = number of independent samples of the signature fluctuations obtained during the non-coherent integration time
g_d and g_{fa} are defined in equations (2.4-3) and (2.4-2).

Only slowly fluctuating log-normal targets are considered in ALARM. For these, $N_i = 1$, so equation (2.4-8) becomes

$$L_f = \frac{\exp\left(\frac{\sigma^2}{2} + \sigma g_d\right)}{\left(1 + g_d / g_{fa}\right)} \qquad (2.4\text{-}9)$$

The user is asked to input the sigma parameter in decibels (σ_{dB}). Since equation (2.4-8) uses sigma in terms of the natural logarithm, the following conversion is necessary:

$$\sigma = 0.1 \quad \ln(10) \quad \sigma_{dB} \qquad (2.4\text{-}10)$$

Design Element 4-5: Aspect Dependency

To satisfy the second requirement in Section 2.4.1, ALARM allows the user to specify in PARAMETER statements the maximum number of azimuth and elevation sectors to be used in defining target fluctuation distributions. Then the user must input the specific number of azimuth and elevation sectors and the bounds of each sector for each run. Finally, the user must specify the fluctuation distribution to be used for each (azimuth, elevation) sector.

To calculate the fluctuation loss for a specific target aspect angle during execution, ALARM uses the following algorithm to find the correct azimuth sector for the current target azimuth Φ:

$$\begin{array}{l}\text{For } i = 1 \text{ to } \mathrm{N}-1 \left(N = \text{number of azimuth sectors}\right), \\ \text{the target is in the } i^{th} \text{ azimuth sector if and only if } A_i \\ \text{is the first sector upper boundary value for which } \varphi < A_i. \\ \text{If } \varphi \geq A_i,\ i = 1 \text{ to } \mathrm{N}-1, \text{ then the target is in the } \mathrm{N}^{th} \text{ azimuth sector.}\end{array} \tag{2.4-11}$$

A similar algorithm is used to find the correct elevation sector for a target with elevation Ψ:

$$\begin{array}{l}\text{For j} = 1 \text{ to } \mathrm{M}-1 \left(M = \text{number of elevation sectors}\right), \\ \text{the target is in the } j^{th} \text{ elevation sector if and only if } E_j \\ \text{is the first sector upper boundary value for which } \Psi < E_j. \\ \text{If } \Psi \geq E_j,\ j = 1 \text{ to } \mathrm{M}-1, \text{ then the target is in the } \mathrm{M}^{th} \text{elevation sector.}\end{array} \tag{2.4-12}$$

2.4.3 Functional Element Software Design

This section contains the software design necessary to implement the functional element requirements described in Section 2.4.1 and the design approach described in Section 2.4.2. Section 2.4.3 is organized as follows: the first subsection describes the subroutine hierarchy and gives descriptions of the relevant subroutines; the next subsection contains logical flow charts and describes all important operations represented by each block in the charts; the last subsection contains a description of all input and output data for the functional element as a whole and for each subroutine that implements fluctuation loss.

Fluctuation Loss Subroutine Design

The FORTRAN call tree implemented for the Fluctuation Loss Functional Element in the ALARM 3.0 code is shown in figure 2.4-1. The diagrams depict the structure of the entire model for this functional element, from ALARM (the Main program) through the least significant subroutine implementing fluctuation loss. Subroutines which directly implement the functional element appear as shaded blocks. Subroutines which use functional element results appear with bands at the ends. Each of these subroutines is described briefly in table 2.4-1.

.

Table 2.4-1 Subroutine Descriptions

MODULE NAME	DESCRIPTION
GETRCS	Extracts and interpolates the RCS of the target
PULDOP	Cycles through flight path or plot matrix points, controls calculation of factors in radar range equation for pulse doppler radar
PULSED	Cycles through flight path or plot matrix points, controls calculation of factors in radar range equation for pulsed radar
RCSERR	Checks for legality of user input data for the target RCS and fluctuation factors
RCSINP	Reads in the target RCS and fluctuation factors
RCSINT	Performs initial processing on user inputs for target RCS and fluctuation factors
RCSPRT	Prints out user inputs for target RCS and fluctuation factors
THRESH	Calculates integration gain and fluctuation loss (or the detection threshold of the radar) given probability of detection and false alarm
Note: Modules implementing the signature fluctuation functional element are identified in **bold** letters	

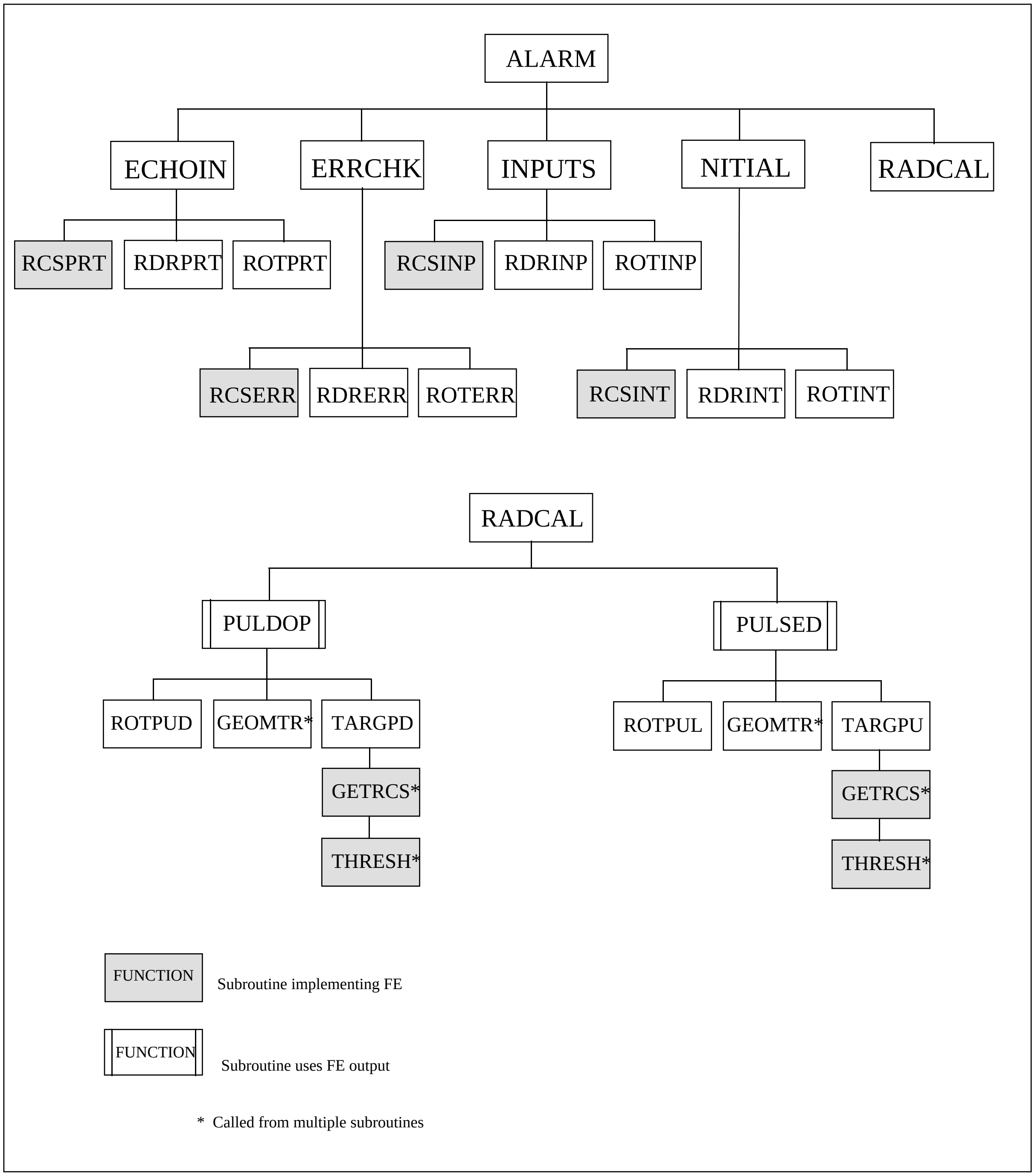

Figure 2.4-1 Call Hierarchy for Fluctuations

Functional Flow Diagram

Figure 2.4-2 shows the top-level logical flow of the signature fluctuations implementation. Subroutine names appear in parentheses at the bottom of each process block. The numbered blocks are described below.

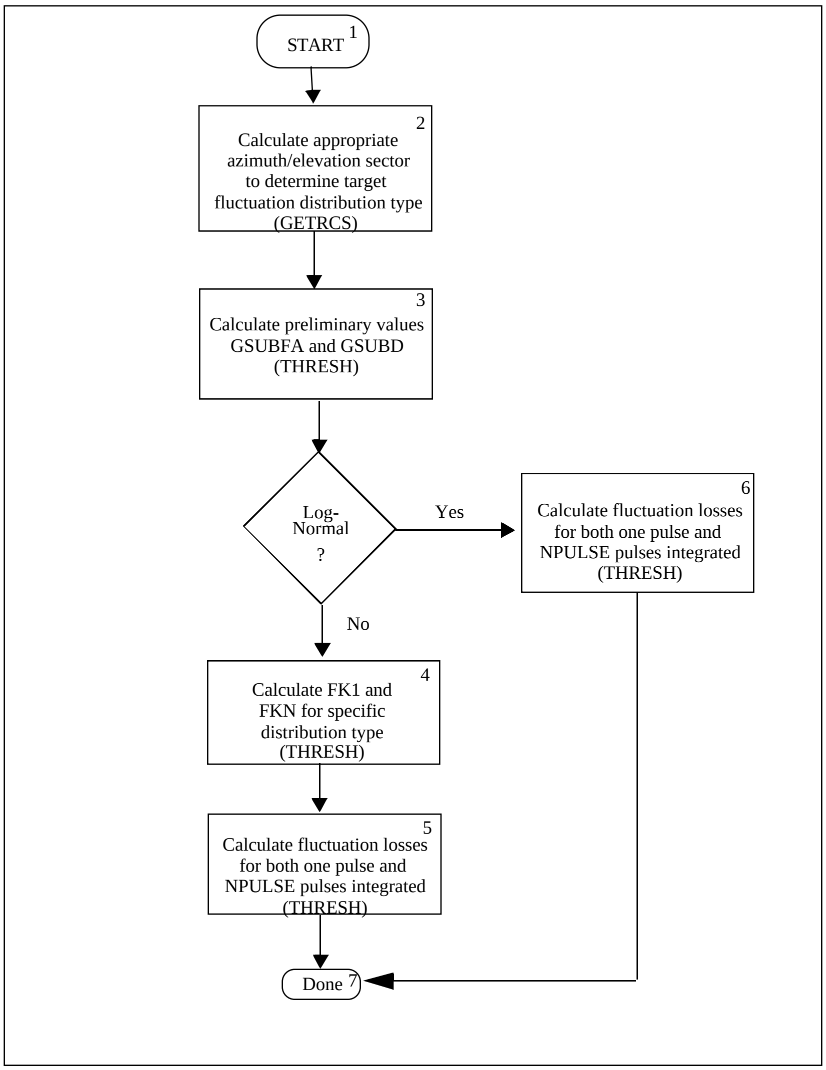

Figure 2.4-2 Signature Fluctuation Logical Flow

Block 1: The radar detection calculations are handled by subroutine RADCAL which calls PULDOP for pulse doppler radars and PULSED for pulse or CW radars. PULDOP calls TARGPD and PULSED calls TARGPU to handle portions of those calculations. TARGPD and TARGPU each call subroutine GETRCS to calculate both the RCS and signature fluctuations portions of the target signature for each target position.

Block 2: Subroutine GETRCS uses the algorithms described in equations (2.4-10) and (2.4-11) to calculate the azimuth and elevation indices (IAZX, JELX) for the correct fluctuations aspect segment for the current target location. Then GETRCS calls subroutine THRESH with parameters including ITTYPE (IAZX, JELX), the fluctuation distribution type for that aspect sector. (Note that THRESH is used to calculate detection threshold in an earlier call)

Block 3: The variables GSUBFA (g_{fa}) and GSUBD (g_d) are used for all fluctuation distributions. Thus, they are calculated using equations (2.4-2) and (2.4-3) before consideration of the distribution type.

Block 4: If the fluctuation distribution is not log-normal, then equation (2.4-5) will be used to compute the fluctuation loss. The code branches to determine the values of the kF term in the exponent of that equation for both a single pulse (FK1 for $N_p = 1$) and for the user-input number of pulses integrated (FKN for N_p = NPULSE).

For the case of a non-fluctuating target (ITYPE=0), ALARM implements equation (2.4-4) by using equation (2.4-5) with extremely large negative values of kF for both cases (FK1 = FKN = -1,000,000).

For the Swerling distributions (ITYPE = 1,2,3,4), the values of kF are calculated according to equation (2.4-6) with $N_p = 1$ for FK1 and N_p = NPULSE for FKN. The calculation of fluctuation losses for the general chi-square and Weinstock distributions is independent of the number of pulses integrated. For the general chi-square distribution, both FK1 and FKN are equal to the product of the user inputs CHNDF (corresponding to k in equation (2.4-5)) and CORLB (corresponding to F). For the Weinstock distribution, both FK1 and FKN are simply equal to CHNDF, as described by equation (2.4-7).

Block 5: Fluctuation losses ABSLF1 for $N_p = 1$ and ABSLFN for N_p = NPULSE are calculated using equation (2.4-5) based on preliminary values calculated in Blocks 3 and 4. Note that for a non-fluctuating target, the extremely small exponent (-10^6) gives a value very close to 1.0 for most numbers raised to that power.

Block 6: For log-normal distributions (ITYPE = 7), the user input SGDB is converted to appropriate units to obtain SIGMA, the standard deviation of ln (S/N). Then equation (2.4-9) is used to calculate the fluctuation loss. (ABSLF1 = ABSLFN since equation (2.4-9) is independent of the number of pulses integrated.)

Block 7: In THRESH, the fluctuation losses are converted to decibels (DBLF1 and DBLFN) and included when calculating integration gain. This integration gain is then used in either PULSED or PULDOP in the calculation of the signal-to-interference ratio.

Signature Fluctuation Inputs and Outputs

The outputs of this functional element are the fluctuation losses given in table 2.4-2. User inputs which affect signature fluctuation are given in table 2.4-3. In addition to specific input variables listed, this functional element also makes use of the aspect angles of the target with respect to the radar.

Table 2.4-2 Signature Fluctuation Outputs

VARIABLE NAME	DESCRIPTION
DBLF1	Fluctuation loss for 1 pulse integrated (dB)
DBLFN	Fluctuation loss for NPULSE pulses integrated (dB)

Table 2.4-3 User Inputs for Signature Fluctuation

DATABLOCK NAME	VARIABLE NAME	DESCRIPTION
DATARADR	NPULSE	Number of pulses integrated
DATARADR	PSUBFA	Probability of false alarm
DATARADR	PSUBD	Probability of detection
DATARCST	ISYM	Target RCS symmetry: 0 = asymmetric; 1 = symmetric in azimuth
DATARCST	NELFLC	Number of elevation sectors for fluctuation statistics
DATARCST	NAZFLC	Number of azimuth sectors for fluctuation statistics
DATARCST	TGFLEL(I+1)	Starting elevation angle for target fluctuation sector
DATARCST	TGFLAZ(J+1)	Starting azimuth angle for target fluctuation sector
DATARCST	ITTYPE(J,I)	Target fluctuation model: 0 = non-fluctuating 4 = Swerling 4 1 = Swerling 1 5 = Chi-square 2 = Swerling 2 6 = Weinstock 3 = Swerling 3 7 = Log-normal
DATARCST	CHINDF(J,I)	Number of degrees of freedom for chi-square and Weinstock target models
DATARCST	CORELB(J,I)	Number of correlated blocks for chi-square target model
DATARCST	SIGDB(J,I)	Sigma parameter of a log-normal distribution

The variable ISYM is used to determine whether or not the azimuth sectors input by the user are complete for azimuths from -180^o to +180^o (ISYM =0), or whether they include only azimuths ranging from 0^o to 180^o (ISYM = 1) which must be replicated symmetrically for azimuths ranging from 0^o to -180^o.

Inputs and outputs for the major routines implementing the signature fluctuation functional element are given in tables 2.4-4 through 2.4-6. All three of these subroutines also perform functions unrelated to fluctuations. Thus, the inputs and outputs related to signature fluctuation are printed in bold.

Table 2.4-4 Subroutine GETRCS Inputs and Outputs

SUBROUTINE GETRCS					
INPUTS			OUTPUTS		
NAME	TYPE	DESCRIPTION	NAME	TYPE	DESCRIPTION
AZASP	Argument	Target azimuth	SIGMAT	Argument	Target RCS at viewing angles AZASP and ELASP (square meters)
ELASP	Argument	Target elevation viewing angle	GANINT	Common RADPAR	Integration gain for a pulse radar (absolute)
NAZFLC	Common RCSTAB	Number of azimuth sectors in the fluctuation type table	GNINTS	Common OPTPRF	Array of integration gains for each PRF of a pulse doppler radar (absolute)

Table 2.4-4 Subroutine GETRCS Inputs and Outputs

SUBROUTINE GETRCS					
INPUTS			OUTPUTS		
NAME	TYPE	DESCRIPTION	NAME	TYPE	DESCRIPTION
NELFLC	Common RCSTAB	Number of elevation sectors in the fluctuation type table			
TGFLAZ	Common RCSTAB	Array of azimuth sector limits in the fluctuation type table (radians)			
TGFLEL	Common RCSTAB	Array of elevation sector limits in the fluctuation type table			
ITTYPE	Common RCSTAB	Array of fluctuation distribution types for aspect sectors			
CHINDF	Common RCSTAB	Array of number of degrees of freedom for chi-square and Weinstock distributions			
CORELB	Common RCSTAB	Array of number of blocks correlated for chi-square distributions			
SIGDB	Common RCSTAB	Array of sigma parameters for log-normal distributions			
NPULSE	Common RADPAR	Number of pulses integrated for pulse radar			
NPULSS	Common RADPAR	Array of number of pulses integrated for each PRF			
PSUBD	Common RADPAR	Probability of detection			

Table 2.4-4 Subroutine GETRCS Inputs and Outputs

SUBROUTINE GETRCS					
INPUTS			OUTPUTS		
NAME	TYPE	DESCRIPTION	NAME	TYPE	DESCRIPTION
PSUBFA	Common RADPAR	Probability of false alarm			
DELAZR	Common RCSTAB	Azimuth spacing of RCS table (radians)			
DELELR	Common RCSTAB	Elevation spacing of RCS table (radians)			
IRADAR	Common RADPAR	Radar type, 1 if pulse doppler 2 if pulse			
ISQLAW	Common RADPAR	0 = linear detection 1 = square law detector			
NAZRCS	Common RCSTAB	Number of azimuth RCS points in the table			
NELRCS	Common RCSTAB	Number of elevation RCS points in the table			
NPRFS	Common RADPAR	Number of PRFs used in a pulse doppler radar			
PI HALFPI	Common CONSTR	π $\pi/2$			
RCSSQM	Common RCSTAB	Array of RCS values for each azimuth and elevation in the RCS table (square meters)			

Table 2.4-5 Subroutine RCSINT Inputs and Outputs

SUBROUTINE RCSINT					
INPUTS			OUTPUTS		
NAME	TYPE	DESCRIPTION	NAME	TYPE	DESCRIPTION
NAZFLC	Common RCSTAB	Number of azimuth sectors in the fluctuation type table	**NAZFLC**	Common RCSTAB	Number of azimuth sectors in the fluctuation type table
NELFLC	Common RCSTAB	Number of elevation sectors in the fluctuation type table	**TGFLAZ**	Common RCSTAB	Number of elevation sectors in the fluctuation type table
TGFLAZ	Common RCSTAB	Array of azimuth sector limits in the fluctuation type table (radians)	**ITTYPE**	Common RCSTAB	Array of fluctuation distribution types for aspect sectors
TGFLEL	Common RCSTAB	Array of elevation sector limits in the fluctuation type table	**CHINDF**	Common RCSTAB	Array of number of degrees of freedom for chi-square and Weinstock distributions
ITTYPE	Common RCSTAB	Array of fluctuation distribution types for aspect sectors	**CORELB**	Common RCSTAB	Array of number of clocks correlated for chi-square distributions

Table 2.4-5 Subroutine RCSINT Inputs and Outputs

SUBROUTINE RCSINT					
INPUTS			OUTPUTS		
NAME	TYPE	DESCRIPTION	NAME	TYPE	DESCRIPTION
CHINDF	Common RCSTAB	Array of number of degrees of freedom for chi-square and Weinstock distributions	**SIGDB**	Common RCSTAB	Array of sigma parameters for log-normal distributions
CORELB	Common RCSTAB	Array of number of blocks correlated for chi-square distributions	RCSSQM	Common RCSTAB	Array of RCS values (square meters), indexed by azimuth and elevation
SIGDB	Common RCSTAB	Array of sigma parameters for log-normal distributions	DELAZR	Common RCSTAB	Azimuth spacing of RCS table
ISYM	Common RCSTAB	1 =RCS and fluctuations tables symmetric in azimuth 0 =Tables not symmetric	DELELR	Common RCSTAB	Elevation spacing of RCS table
DEGRAD	Common CONSTR	Conversion factor, degrees to radians	TGFLEL	Common RCSTAB	Array of elevation sector limits in the fluctuation type table
RCSIN	Common RCSTAB	Array of user-input target RCS values (may be either dB or square meters) Note: This array is set equivalent to the array RCSSQM which is listed in the common block			
DELAZD	Common RCSTAB	Azimuth increment in RCS table (degrees)			
DELELD	Common RCSTAB	Elevation increment in RCS table (degrees)			
ISQM	Common RCSTAB	0 =RCS values input in dB 1 =RCS values input in square meters			
IXSTRT	Common RCSTAB	Index of first azimuth RCS value for each elevation			
NAZRCS	Common RCSTAB	Number of azimuths for each elevation in the RCS table			
NELRCS	Common RCSTAB	Number of elevations in RCS table			
JELMIN	Common RCSTAB	Minimum elevation index for which RCS values are given			
JELMAX	Common RCSTAB	Maximum elevation index for which RCS values are given			
RCSSQM	Common RCSTAB	Array of RCS values			
RCSXDB	Common RCSTAB	RCS scale factor used to increase or decrease the RCS data block			

Table 2.4-6 Subroutine THRESH Inputs and Output

SUBROUTINE THRESH					
INPUTS			**OUTPUTS**		
NAME	**TYPE**	**DESCRIPTION**	**NAME**	**TYPE**	**DESCRIPTION**
ISQLAW	Argument	0 =Linear detector 1 =Square-law detector	CONTOR	Argument	The one-pulse signal-to-noise ratio (dB) required for target detection
ITYPE	Argument	Fluctuation type indicator 0 =Non-fluctuating 1 =Swerling 1 2 =Swerling 2 3 =Swerling 3 4 =Swerling 4 5 =Chi-square 6 =Weinstock 7 =Log-normal	**DBGAIN**	Argument	The integration gain (dB) for NPULSE pulses integrated (Fluctuation loss is included in this value)
NPULSE	Argument	Number of pulses integrated			
PSUBFA	Argument	Probability of false alarm			
PSUBD	Argument	Probability of detection			
CHNDF	Argument	Number of degrees of freedom for chi-square or Weinstock distribution			
CORLB	Argument	Number of blocks correlated for chi-square distribution			
SIGDB	Argument	Sigma parameter of log-normal distribution			

2.4.4 Assumptions and Limitations

The probability of detection P_d (variable PSUBD) and the probability of false alarm P_{fa} (PSUBFA) must be within certain bounds in order to use the approximations in equations (2.4-5) through (2.4-9). Based on [A.1-25, page 65], P_d must be in the range [0.1, 0.9] and P_{fa} must be in the range $[10^{-12}, 10^{-4}]$.

The fluctuation distributions used in ALARM are only approximations to actual target fluctuations.